

Acceleration Issues and Design

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Video conference
Nov.6, 2000

Content

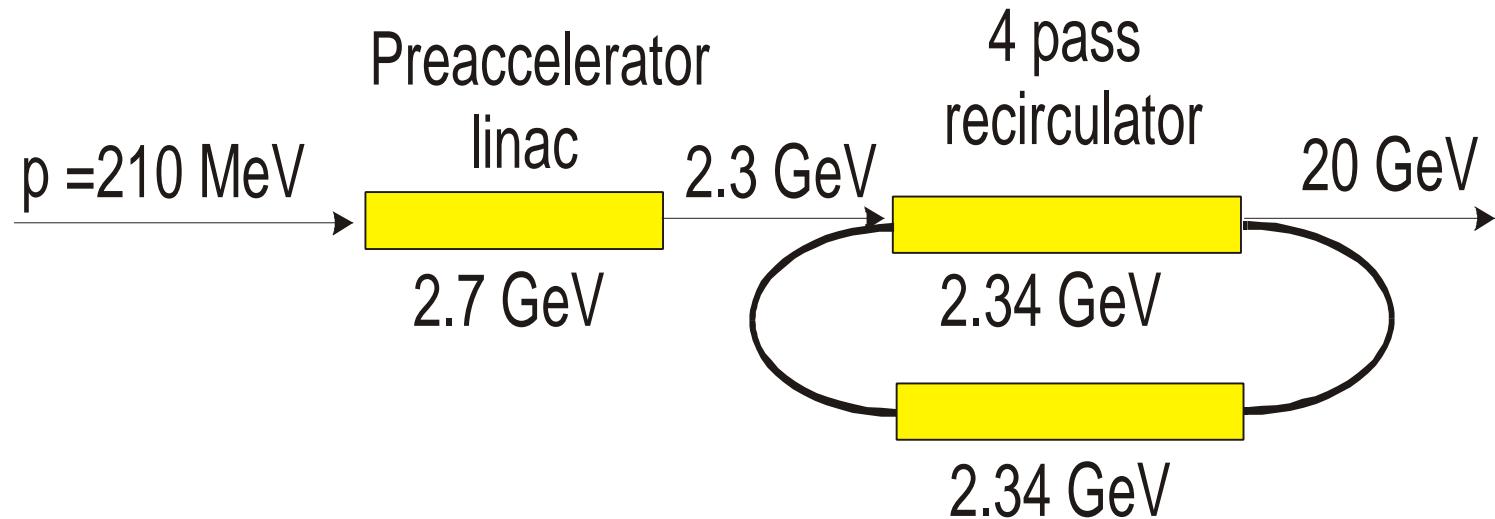
1. Machine layout and main parameters
2. Linear preaccelerator
3. Recirculator
4. Conclusions & questions

Machine layout and main parameters

Basic MAD Parameters

Injection momentum/Kinetic energy	210/130 MeV
Final energy	20 GeV
Initial normalized acceptance	9.3 \rightarrow 15 mm·rad
Initial longitudinal acceptance, $\Delta p L_b / m_\mu$	150 mm ± 290 mm
L_b	$\Delta p/p$
Number of bunches per pulse	67
Number of particles per bunch/per pulse	$4.4 \cdot 10^{10} / 3 \cdot 10^{12}$
Bunch frequency/Accelerating frequency	201.25/201.25 MHz
Average repetition rate	15 Hz
Pulse structure	6 bunches at 50 Hz with 2.5 Hz rep.rate
Beam Power	150 kW

MAD layout



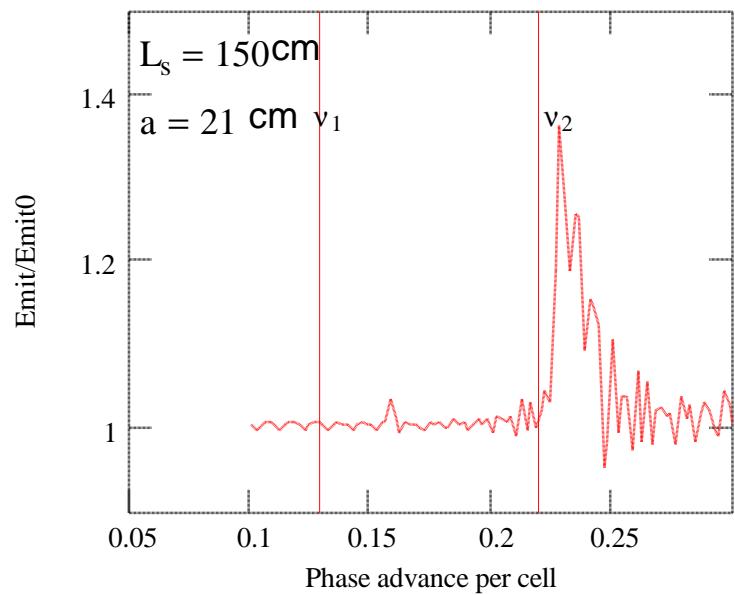
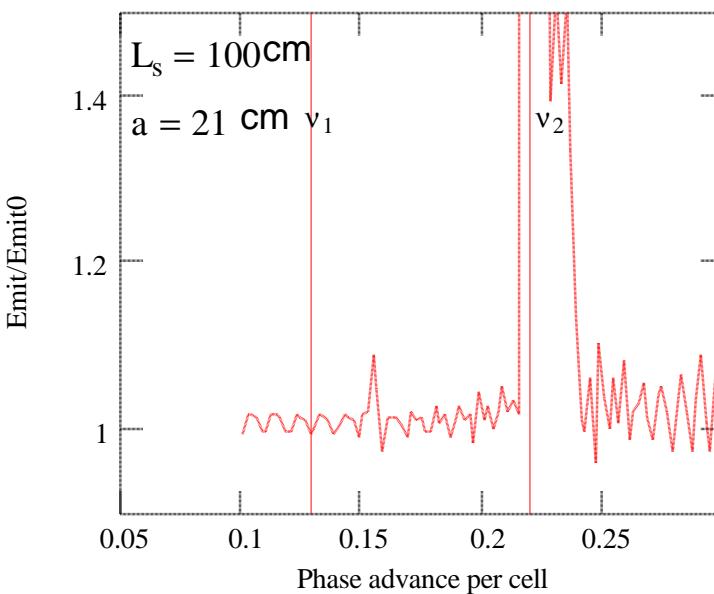
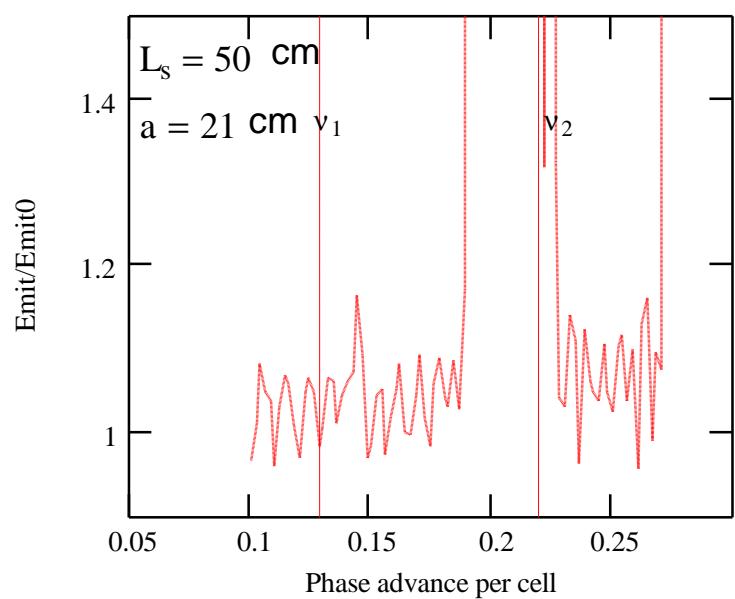
Linear Preaccelerator

- 1 Acceleration from 130 to 2300 MeV
- 2 Longitudinal dynamics is well understood
- 3 RF
 - SC two cell cavities
 - Short cryo-modules - 2 cavities, ~5 m
 - Long cryo-modules - 4 cavities, ~10 m
- 4 Transverse dynamics
 - Solenoidal focusing
 - Focusing non-linearity

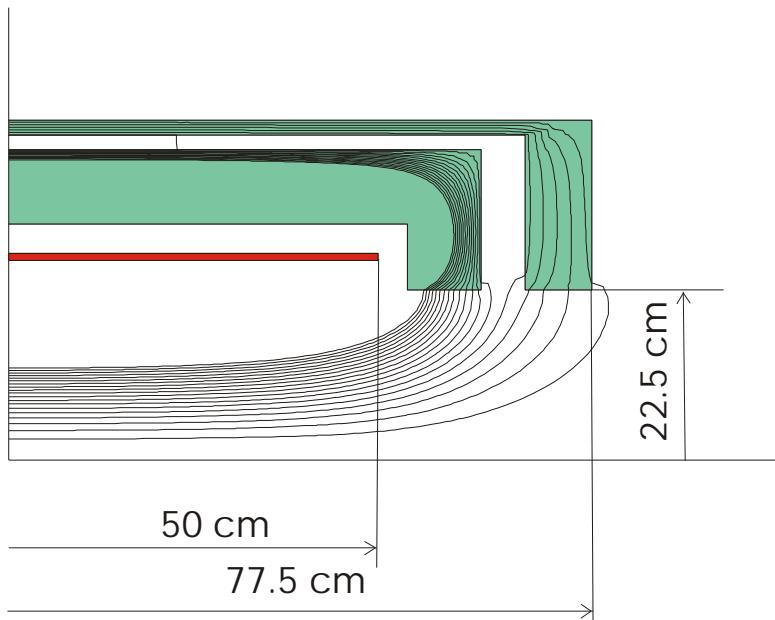
Focusing element length (~ 1 m) is comparable to its aperture (0.25 m)

$$\frac{\Delta F}{F} \approx \frac{r^2}{2} \frac{\int B'^2 ds}{\int B^2 ds} \approx \frac{r^2}{3aL} \xrightarrow[L/r=4, r \approx 0.8a]{} 0.07$$

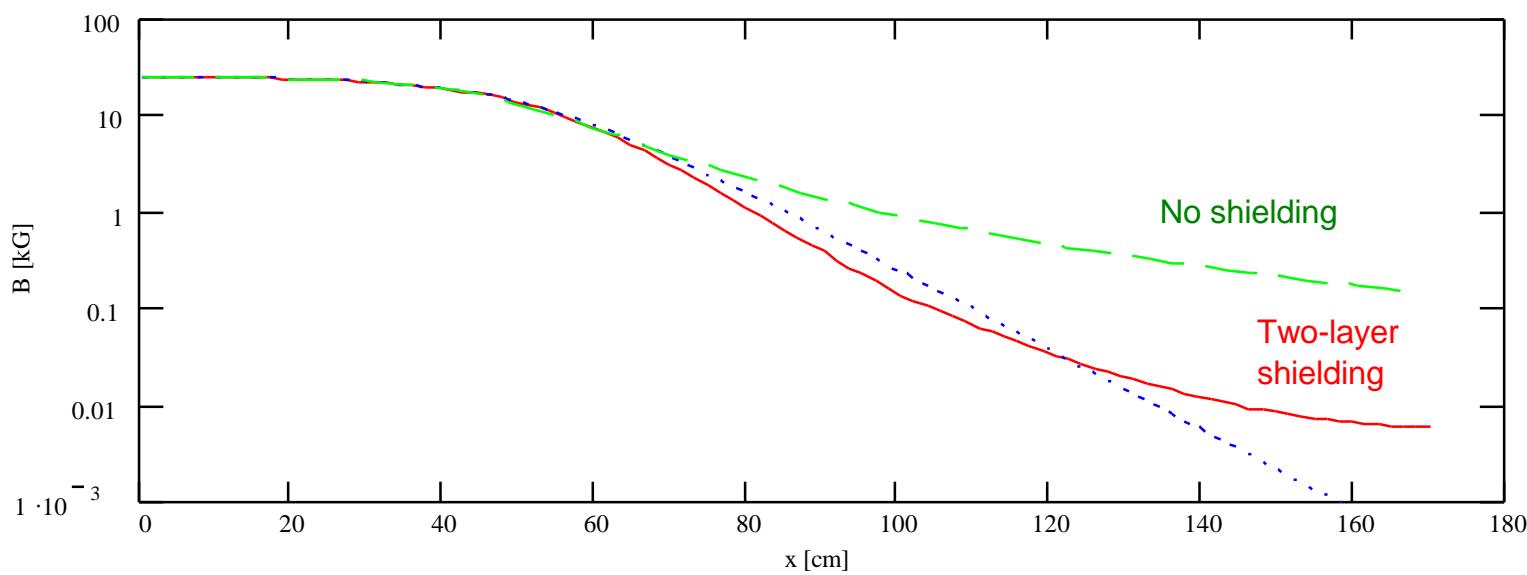
- Shielding solenoid's field
- Phase advance per cell is changed from 0.25 to 0.175
- Nearest plans
 - Cavity focusing
 - Particle tracking with non-linear focusing of solenoids and lenses

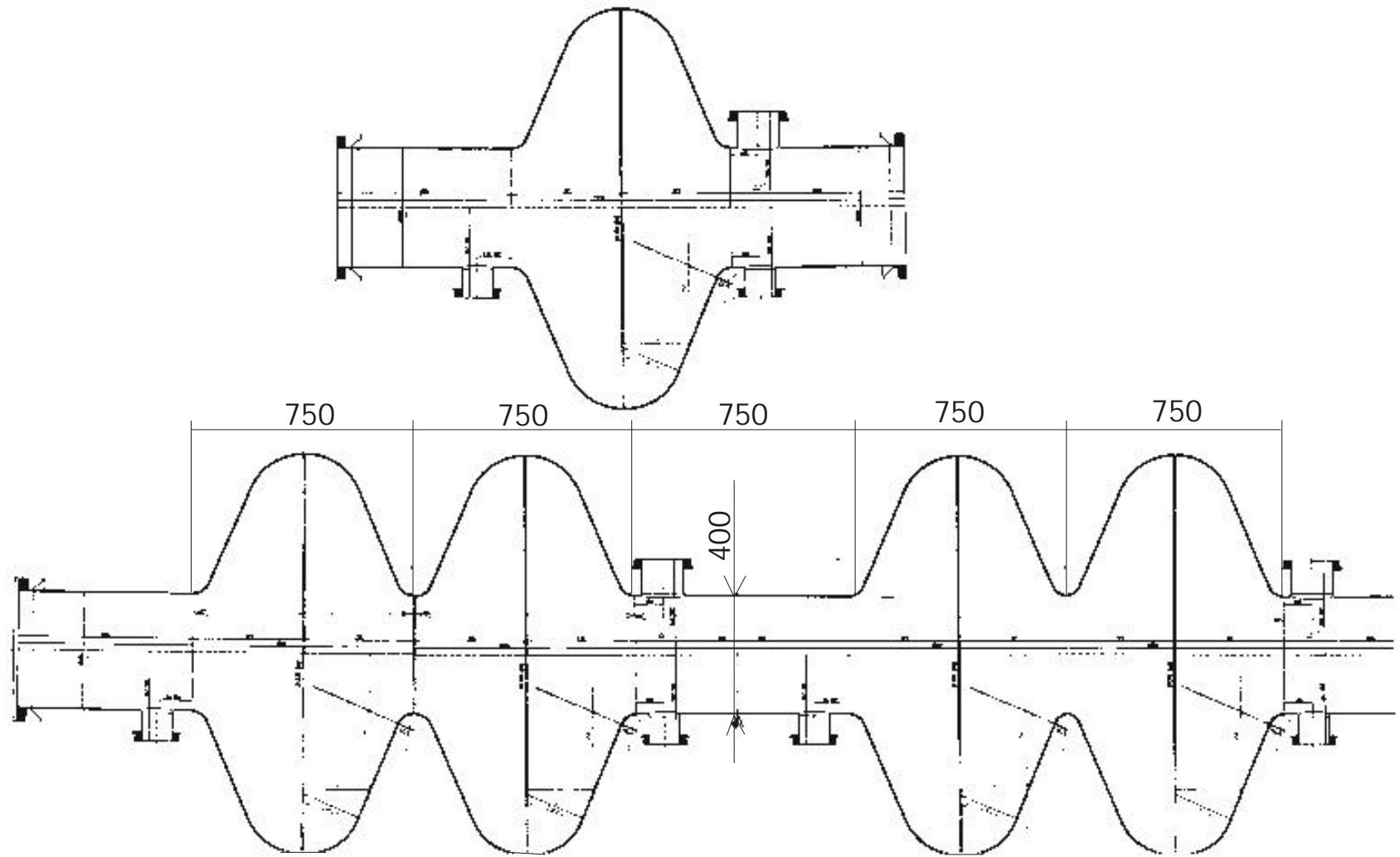


Relative emittance change after passing 50 solenoidal lenses of different length:
 $\epsilon_n = 15 \text{ mm rad}$,
 $v_0 = 0.175$ (0.25 before !!!)
 $\Delta v/v \approx \Delta p/p = \pm 26\%$

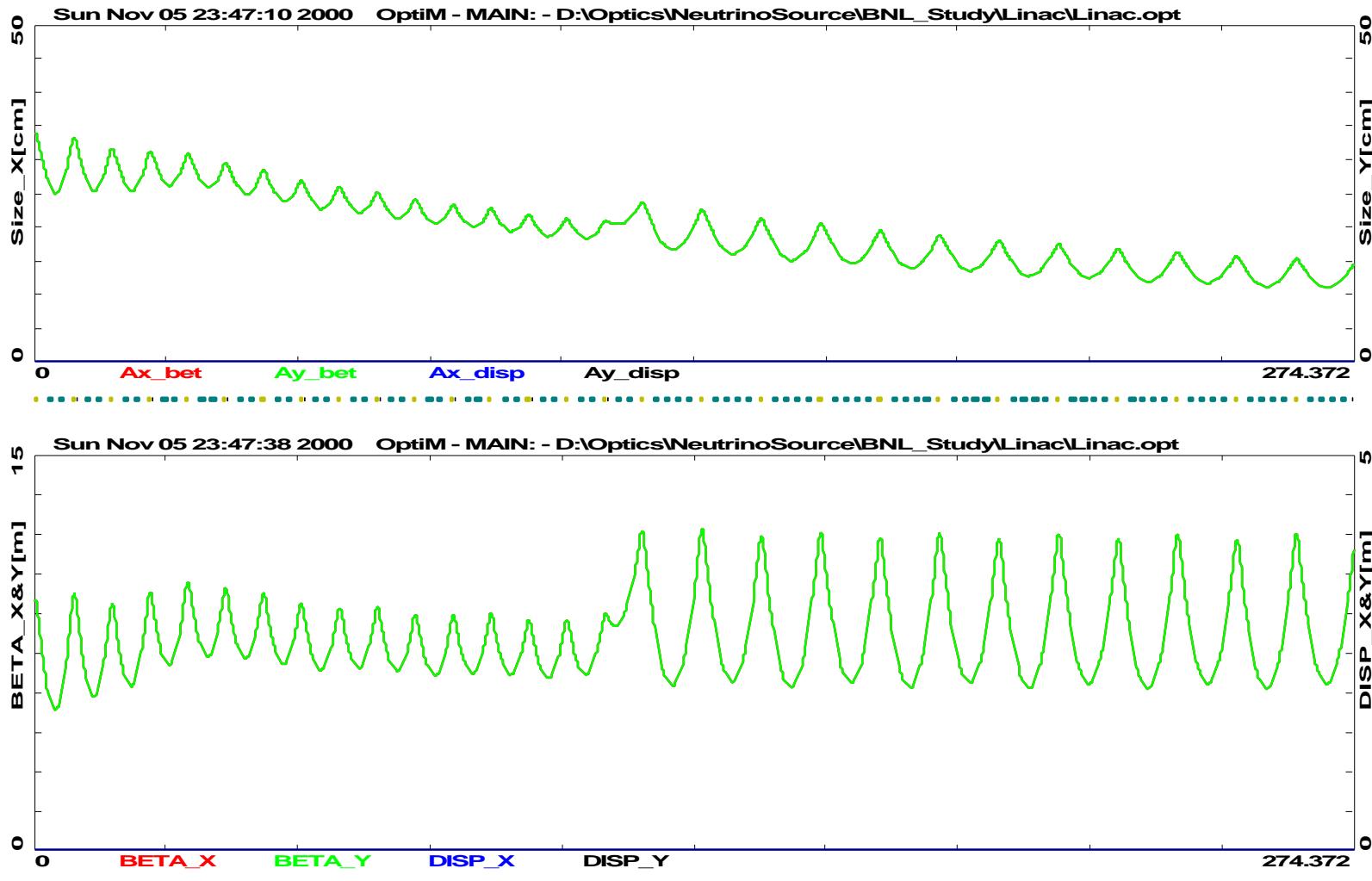


Magnetic lines and magnetic field on the axis





Short cryo-module sketch



Beam size for the acceptance of 15 mm at the linac front-end

Maximum beam size in cavities $2a = 28*2$ cm
 in solenoids $2a = 34*2$ cm

- Should we go to 10-15 single single cavity cryo-modules ?
 ◆ Significant drop of the accelerating gradient

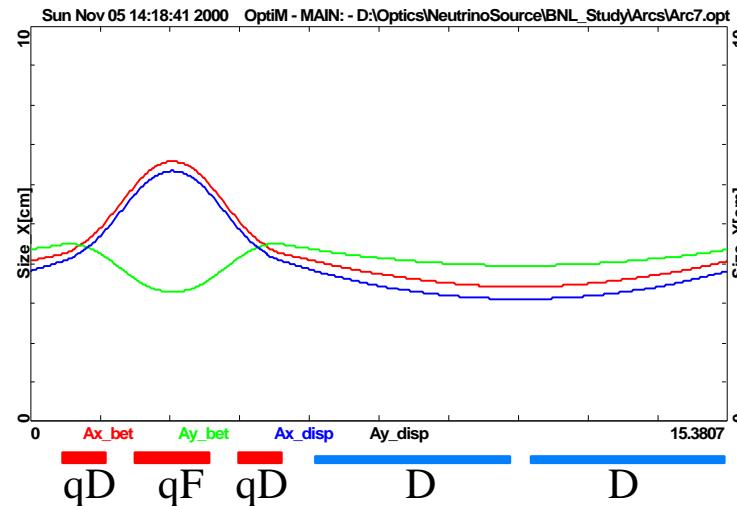
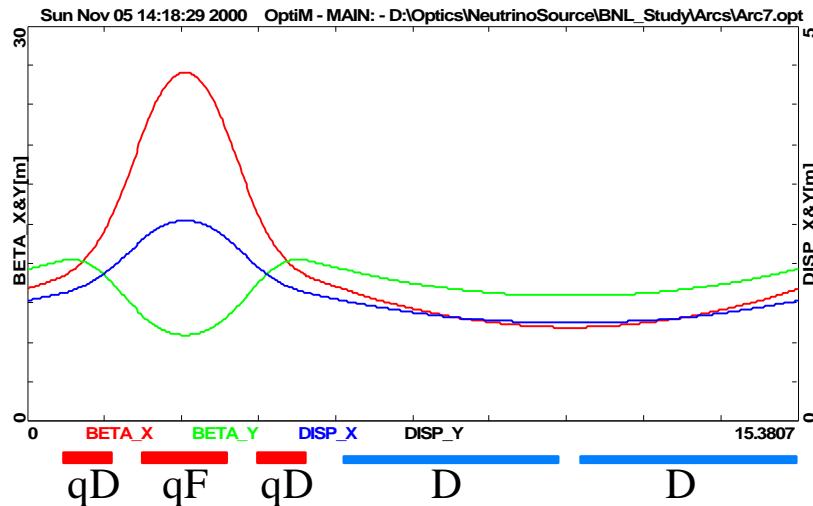
Main parameters for recirculation arcs and linacs

	Initial Energy [GeV]	Initial total energy acceptance	Transverse acceptance*, X&Y [mm·mrad]	Gang phase of the linac [deg]
	2.3	$\pm 6.8\%$	656	-4
Arc 1	4.6	$\pm 4.9\%$	365	20
Arc 2	6.8	$\pm 4.4\%$	272	22
Arc 3	9.0	$\pm 3.5\%$	226	22
Arc 4	11.1	$\pm 2.8\%$	200	22
Arc 5	13.3	$\pm 2.4\%$	182	22
Arc 6	15.4	$\pm 2.2\%$	171	10
Arc 7	17.7	$\pm 2.0\%$	163	10
	20	$\pm 1.8\%$	157	

$$M_{56}=1.3 \text{ m}$$

* Emittance dilution of 100%, $(e_n = e_{n0} 2^{n/8})$

Arc 7 lattice



Energy = 17.78 GeV

Total Length for one period = 15.38 m

Total Length for 12 periods = 184.56 m (only half of the linac length)

Betatron phase advance per cell: $Q_x=Q_y=0.25$

Quads

Name	L[cm]	G[kG/cm]	Aperture=2a [cm]	Pole field [kG]
qD	100	-1.48	$\sqrt{9.05 \cdot 3.25} \cdot 2 + 2 = 12.8$	9.47
qF	170	1.616	$\sqrt{7.09 \cdot 4.09} \cdot 2 + 2 = 12.8$	10.3

Dipoles (square dipole bend along the beam)

Name	L[cm]	B[kG]	Gap[cm]	Horiz. apert. [cm]	Sagitta [cm]
D	434.03	18	9+2=11	$(5.5+1) \cdot 2 = 13$	± 5.1

Spreader layout

